

What is claimed is:

1. A method of manufacturing a semiconductor device, comprising:

5 forming an insulating film over a semiconductor substrate;

forming a lower layer of a lower-electrode conductive film on the insulating film while keeping substrate temperature at a temperature higher than room temperature and lower than 300 °C;

10 forming an upper layer of the lower-electrode conductive film on the lower layer, and constituting a lower-electrode conductive film by the upper and lower layers;

15 forming a ferroelectric film on the lower-electrode conductive film;

forming an upper-electrode conductive film on the ferroelectric film; and

20 forming a ferroelectric capacitor by patterning the upper-electrode conductive film, the ferroelectric film, and the lower-electrode conductive film.

2. The method according to claim 1, wherein the lower layer of the lower-electrode conductive film is formed by sputtering.

25 3. The method according to claim 1, wherein any one of a titanium layer and a layer of an alloy of titanium and noble metal is formed as the lower layer of the lower-electrode conductive film.

4. The method according to claim 3, wherein an orientation direction of the lower layer of the lower-electrode conductive film is a (002) direction.

5. The method according to claim 1, wherein any one of a single-layer film and a multilayer film, which are made of any one of platinum, iridium, ruthenium, palladium, platinum oxide, iridium oxide, ruthenium oxide, palladium oxide, and an alloy thereof, is formed as the upper layer of the lower-electrode conductive film.

6. The method according to claim 5, wherein an orientation direction of the upper layer of the lower-electrode conductive film is a (222) direction.

7. The method according to claim 1, wherein any one of a film made of any one of  $\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$ ,  $(\text{Pb},\text{La})(\text{Zr},\text{Ti})\text{O}_3$ ,  $\text{SrTiO}_3$ ,  $(\text{Ba},\text{Sr})\text{TiO}_3$ ,  $\text{SrBi}_2(\text{Ta}_x\text{Nb}_{1-x})_2\text{O}_9$  ( $0 < x \leq 1$ ), and  $(\text{Pb},\text{La})(\text{Zr},\text{Ti})\text{O}_3$ , and a film made of a material in which  $\text{Pb}(\text{Zr},\text{Ti})\text{O}_3$  is doped with at least any one of calcium, strontium, and lanthanum is formed as the ferroelectric film.

8. The method according to claim 7, wherein an orientation direction of the ferroelectric film is a (111) direction.

9. The method according to claim 1, wherein quality of the insulating film is improved by exposing a surface of the insulating film to  $\text{NH}_3$  plasma before the lower layer of the lower-electrode conductive film is formed.

10. The method according to claim 1, wherein  $\text{H}_2\text{O}$  is

added to an atmosphere in which the lower layer of the lower-electrode conductive film is formed.